IME01-001

1. An apparatus for simultaneously performing multiple, independently controlled, chemical reactions, comprising:

a printed circuit board mounted on a heat sink;

on said printed circuit board, a first array of one or more blocks, said blocks having high thermal conductivity;

on said array of blocks, a chip formed of material that has low thermal conductivity;

a plurality of reaction chambers in said chip, whereby at least one reaction chamber symmetrically overlies a single block of the first array and thermal conductance between each reaction chamber and the block that it overlies is much greater than thermal conductance between any two reaction chambers;

a heating source and a temperature sensor between the chip and each high thermal conductivity block; and

electrical leads from each heat source and each temperature sensor whereby each heating source can be independently controlled.

2. The apparatus described in claim 1 wherein said chemical reactions are selected from the group consisting of chemical reactions whose rate is temperature dependent, including polymerase chain reactions.

3. The apparatus described in claim 1 wherein each of said reaction chambers has a depth between about 0.05 and 1 mm and a volume between about 0.1 and 25 mm^3 and

wherein there are between about 1 and 128 chambers per sq. inch.

4. The apparatus described in claim 1 wherein the soft layer is softer than 100 and harder than 1, when measured on a Shore D Durometer, and wherein said high thermal conductivity blocks have a thermal conductivity that is between about 2 and 500 W/m.K.

5. The apparatus described in claim 1 wherein the chip is reusable and is selected from the group consisting of polymers, elastomers, glass, silica, and ceramics.

6. The apparatus described in claim 1 wherein the chip is disposable and is selected from the group consisting of polymers, elastomers, glass, silica, and ceramics.

7. An apparatus for simultaneously performing multiple, independently controlled, polymerase chain reactions, comprising:

a printed circuit board having upper and lower surfaces;

said lower surface being in direct contact with a layer of electrically insulating material which is in direct contact with a heat sink;

on said upper surface, an electrically insulating layer of soft material having high thermal conductivity;

on the soft layer, an array of resistance heaters and temperature sensors;

solder bumps that extend downwards from the array and pass through said soft layer

to provide electrical connections between the array and the circuit board thereby enabling each heating source to be independently controlled;

on each heater and sensor of the array, and in direct contact with the soft layer, a block having high thermal conductivity;

a chip, formed of material that is thermally insulating;

means for uniformly pressing the chip against the blocks, including surface profiles for the blocks and the chip that facilitate rapid alignment between chip and the blocks;

a layer of contact enhancing material between the chip and the blocks;

reaction chambers within said chip, at least one reaction chamber symmetrically overlying each block when the chip is pressed against the blocks; and

means for filling and emptying each chamber with reagents used in said polymerase chain reaction.

8. The apparatus described in claim 7 wherein said means for uniformly pressing the chip against the blocks further comprises:

sidewalls attached to the chip, said sidewalls extending downwards from the chip by an amount such that, when the chip touches the blocks said sidewalls just contact the printed circuit board, thereby forming an airtight enclosure; and

a hole that passes through both the heat sink and the printed circuit board thereby enabling air in said enclosure to be evacuated.

9. The apparatus described in claim 7 wherein said means for uniformly pressing the chip against the blocks further comprises:

a covering case, having a ceiling, that rests on the printed circuit board and that encloses both the blocks and the chip; and

extending downwards from said ceiling, rods having free ends that are pointed , each having a length such that, when the covering case rests on the circuit board, said rods press down on the chip.

10. The apparatus described in claim 7 wherein said means for uniformly pressing the chip against the blocks further comprises:

a fixture that includes an additional heat sink, an additional printed circuit board, and additional blocks;

said fixture being positioned in an inverted orientation touching the chip whereby said additional heat sink, additional printed circuit board, and additional blocks are aligned relative to said heat sink, printed circuit board, and blocks; and

an adjustable clamp that presses together the fixture, the chip, and the blocks.

11. The apparatus described in claim 7 wherein said layer of electrically insulating material is selected from the group consisting of adhesives, epoxies, polymers, and grease.

12. The apparatus described in claim 7 wherein said layer of soft material is selected

from the group consisting of epoxies, polymers, and grease.

13 The apparatus described in claim 7 wherein the blocks are made of a material selected from the group consisting of silicon, metals, and ceramics.

14. The apparatus described in claim 7 wherein said layer of contact enhancing material is selected from the group consisting of polymers, rubbers, and grease.

15. An apparatus for simultaneously performing multiple, independently controlled, polymerase chain reactions, comprising:

a printed circuit board having upper and lower surfaces;

said lower surface being in direct contact with a layer of electrically insulating material which is in direct contact with a heat sink;

on said upper surface, an electrically insulating layer of soft material having high thermal conductivity;

on the soft layer, an array of first blocks having high thermal conductivity

on each first block, a resistance heater and a temperature sensor;

in direct contact with each first block, a second block having high thermal conductivity and that is smaller than the first block whereby each heater and sensor on a first block is partially covered by a second block and is partially exposed;

wires that extend downwards from the exposed portions of the heaters and sensors,

that pass through the soft material to make electrical contact to the printed circuit board, thereby enabling each heating source to be independently controlled;

a chip, formed of material that is thermally insulating;

means for uniformly pressing the chip against the second blocks, there being a layer of contact enhancing material between the chip and the second blocks;

reaction chambers within said chip, at least one reaction chamber symmetrically overlying a single second block when the chip is pressed against the blocks; and

means for filling and emptying each chamber with reagents used in said polymerase chain reaction.

16. The apparatus described in claim 15 wherein said means for uniformly pressing the chip against the blocks further comprises:

sidewalls attached to the chip, said sidewalls extending downwards from the chip by an amount such that, when the chip touches the blocks said sidewalls just contact the printed circuit board, thereby forming an airtight enclosure; and

a hole that passes through both the heat sink and the printed circuit board thereby enabling air in said enclosure to be evacuated.

17. The apparatus described in claim 15 wherein said means for uniformly pressing the chip against the blocks further comprises:

a covering case, having a ceiling, that rests on the printed circuit board and that

encloses both the blocks and the chip; and

extending downwards from said ceiling, rods having free ends that are pointed , each having a length such that, when the covering case rests on the circuit board, said rods press down on the chip.

18. The apparatus described in claim 15 wherein said means for uniformly pressing the chip against the blocks further comprises:

a fixture that includes an additional heat sink, an additional printed circuit board, and additional blocks;

said fixture being positioned in an inverted orientation touching the chip whereby said additional heat sink, additional printed circuit board, and additional blocks are aligned relative to said heat sink, printed circuit board, and blocks; and

an adjustable clamp that presses together the fixture, the chip, and the blocks.

19. A process for simultaneously performing multiple, independently controlled, chemical reactions, comprising:

providing, on a heat sink, a printed circuit board on which is an array of blocks, said blocks having high thermal conductivity;

providing an array of reaction chambers in a chip formed of material having low thermal conductivity;

filling each reaction chamber with reagents necessary for said chemical reaction and

then pressing the chip against the blocks in a manner such that at least one reaction chamber symmetrically overlies a single block; and

independently heating each block that is overlaid by a filled reaction chamber whereby the reagents in each chamber are maintained at a constant and uniform temperature for a time period, said temperature and time period being independently adjustable for each chamber.

20. The process described in claim 19 wherein the step of filling each reaction chamber with reagents further comprises using micro-pipettes or syringes.

21. The process described in claim 19 wherein the step of pressing the chip against the blocks further comprises:

attaching sidewalls to the chip, said sidewalls extending downwards from the chip by an amount such that, when the chip touches the blocks said sidewalls just contact the printed circuit board, thereby forming an airtight enclosure; and

evacuating the enclosure through a hole that passes through both the heat sink and the printed circuit board.

22. The process described in claim 19 wherein the step of pressing the chip against the blocks further comprises:

providing a covering case, having a ceiling, that rests on the printed circuit board

and that encloses both the blocks and the chip;

providing rods that extend downwards from said ceiling, each rod having a free end that is pointed and a length such that, when the covering case rests on the circuit board, said rods press down on the chip; and

placing the covering case on the circuit board thereby causing said rods to press the chip against the blocks.

23. The process described in claim 19 wherein the step of pressing the chip against the blocks further comprises:

providing a fixture that includes an additional heat sink, an additional printed circuit board, and additional blocks;

positioning said fixture in an inverted orientation to touch the chip with said additional heat sink, additional printed circuit board, and additional blocks being aligned relative to said heat sink, printed circuit board, and blocks; and

using an adjustable clamp, pressing together the fixture, the chip, and the blocks.

24. The process described in claim 19 wherein said chemical reactions are selected from the group consisting of chemical reactions whose rate is temperature dependent, including polymerase chain reactions.

25. The process described in claim 19 wherein the chip is reusable and is selected from

the group consisting of plastics, polymers, elastomers, glass, silica, and ceramics.

26. The process described in claim 19 wherein the chip is disposable and is selected from the group consisting of plastics, polymers, elastomers, glass, silica, and ceramics.